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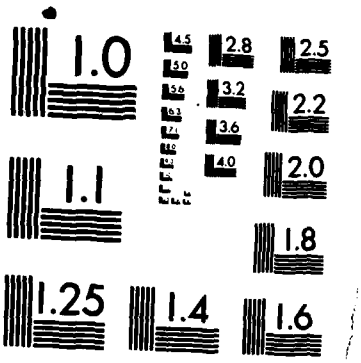

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Dr. Erol Emre

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Final Report on the AFOSR Grant 82-0282

"On a Theory of Control for Linear Systems
Over Rings and Nonlinear/Time-varying Systems"

Duration: July 1982-June 1985

Principal Investigator: Dr. Erol Emre
Dept. of Electrical Engineering
Texas Tech University
Lubbock, TX 79409

1. RESEARCH DESCRIPTION (July 82-July 85)

We will describe our research on the AFOSR Grant 82-0282 referring to the attached list of publications. The results of publications [1-3] and [5-7] were obtained during 82-83 period.

[1-3] extends known results on regulation of linear systems over rings in several directions. [5] gives possibly the first results on decentralized control of linear systems over rings. [6] extends results on skew prime polynomial matrices to the case of arbitrary commutative rings. [7] studies the problem of resulting system order after dynamic feedback. These results were described in more detail in our proposals and reports to the AFOSR.

The results of [4], [8-11] were obtained during 82-85, and are described in detail in the progress report for 82-85. [4] solves the regulation problem for systems with fixed delays (for a large class of neutral systems) for the first time. [8-9] give new approaches and results on stabilization of linear time-varying systems and observers for nonlinear systems. [11] gives new results on minimum norm compensators for model matching.

Next we describe our research during 84-85 period. During this time, our research has concentrated on two main areas:

i) Stabilization of Linear and Nonlinear Time-varying Systems, and

ii) Computational aspects of delay differential systems, in particular, Tschebycheff Approximation.

i) We have considered the existence of continuous families of stabilizing compensators for continuous families of time-varying systems for the first time, and given a full solution to this problem. Then we combine these results with Tychonoff fixed point theorem, to obtain many local and global stabilization criteria for nonlinear systems of the type

$$\dot{x} = F(x,u,t)x+G(x,u,t)u.$$

This is a very large calss and includes all bilinear and many types of polynomial nonlinear systems. Furthermore, our results yield stabilization by linear state-feedback. Furthermore, we have extended Kleinman's Newton type technique to approximate the steady state solution of the Riccati equation, to time-varying systems. We should note that this is very far from a direct application of Newton approximation theory. This provides

new stabilizing laws for linear time-varying systems which are sub-optimal, by linear techniques.

These results are in [12], [14], [16], and [18].

ii) We have developed new techniques for Tschebycheff approximation, for the purpose of computation of stabilizing compensators for delay-differential systems. These results are in [17].

In addition, in [16], we have a solution to globally stable adaptive pole-placement/stabilization with no external inputs and adaptive identification for classes of systems with unknown paarmeters subject to change. Our approach is algorithm-free, conceptually oriented and to some extent uses systems over rings results.

2. LIST OF PUBLICATIONS (July 82-July 85).

A) Journal Publications:

1) E. Emre, "Regulation of linear systems over rings by dynamic output feedback," Systems Control Letters, June 1983.

2) E. Emre and P. Khargonekar, "A note on regulation of linear systems over rings by dynamic output feedback," IEEE Trans. Autom. Conrr., Jan. 1984.

3) E. Emre and P. Khargonekar, "Pole placement for linear systems over Bezout domains," IEEE Trans. Autom. Contr., Jan. 1984.

4) E. Emre and G. Knowles, "Control of linear systems with fixed noncommensurate point delays," IEEE Trans. Autom. Contr., Dec. 1984.

B) Conference Proceeding Papers:

5) E. Emre, "On decentralized control of linear systems over rings," Proc. IEEE Intern. Symp. on Large Scale Systems, Oct. 1982.

6) E. Emre, "Further results on skew prime matrices," Proc. IEEE Conf. on Decis. and Contr., Dec. 1982.

7) E. Emre, "Pole-zero cancellation in linear feedback systems," Proc. IEEE CDC, Dec. 1982.

8) E. Emre, "Observers for nonlinear/time-varying systems," Proc. Allerton Conf., Oct. 1983.

9) E. Emre, "A polynomial fractional approach to linear time-varying systems," Proc. Allerton Conf., Oct. 1983.

10) E. Emre, "On regulation of linear systems by dynamic output feedback," Proc. IEEE CDC, Dec. 1983.

11) E. Emre, "On optimal model matching of linear systems," Proc. Midwest Symp. on Circuits and Systems, June 1984.

12) E. Emre and G. Knowles, "Stabilization of nonlinear time-varying systems; A systems over parameters approach," Proc. Allerton Conf., Oct. 1984.

13) E. Emre and G. Knowles, "Regulation of linear systems with fixed noncommensurate point delays," Proc. IEEE CDC, Dec. 1984.

14) E. Emre and G. Knowles, "A Newton algorithm for computation of the steady state solution of the Riccati equation," Proc. Mathematical Theory of Networks and Systems (MTNS), June 1984, Sweden.

15) E. Emre, "On globally stable adaptive control," MTNS 1984.

16) H.M. Tai, E. Emre and G. Knowles, "Stabilization of certain

nonlinear systems by linear feedback," Proc. IEEE CDC, 1985, to appear.

17) G. Knowles and E. Emre, "A Tschebycheff approximation approach to computation of stabilizing compensators for systems with delays," Proc. IEEE CDC, 1985, to appear.

C) Submitted Papers:

18) E. Emre and G. Knowles, "Continuous stabilization of time-varying systems: a systems over parameters approach," Submitted for publication. Aug. 1984.

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